ABC Need-to-Know Criteria for Very Small Water System Operators

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- Jess Jones (Chair), Operator Training Committee of Ohio
- Richard Bond, Colorado Springs (CO) Utilities
- Don Jackson, South Carolina Environmental Certification Board
- Ken Kerri, California State University, Sacramento, Office of Water Programs
- Thomas Rothermich, City of St. Louis (MO) – Water Division
- Russ Glaser, Clark Public Utilities, Vancouver, Washington
- Martin Nutt, Arkansas Drinking Water Advisory and Operators Licensing Committee
- Wes Haskell, Old Town Water District, Old Town, Maine
- Shawn Bradford, Aquarion Water Company
- Cindy Cook, Minnesota Department of Health, Drinking Water Protection

Introduction

As part of the development of very small water system certification exams, the Association of Boards of Certification (ABC) conducted a job analysis of very small water system operators during 1998. The definition of a very small water system used during the job analysis was a system serving a maximum population of 500 with no treatment other than disinfection. The Need-to-Know Criteria was developed from the results of ABC's 1998 very small water system operator job analysis.

In 2005, ABC's Distribution Validation and Examination (V&E) Committee revised the need-to-know criteria to reflect current terminology used in the item bank. The information in this document reflects the essential job tasks performed by operators and their requisite capabilities. This document is intended to be used by certification programs and trainers to help prepare operators for entry into the profession.

How the Need-to-Know Criteria Was Developed

In 1998, a seven-member job analysis committee was formed to provide technical assistance in the development of the very small water system operator job analysis. During their meeting, this committee developed the list of the important job tasks performed by very small water system operators. The committee also verified the technical accuracy, clarity, and comprehensiveness of the job tasks. The committee then identified the capabilities (i.e., knowledge, skills, and abilities) required to perform the identified job tasks. Identification of capabilities was done on a task by task basis, so that a link was established between each task statement and requisite capability. This process resulted in a final list of 238 job tasks and 178 capabilities.

Task Inventory

A task inventory was developed from the data collected during the committee meeting. The inventory included 8-point rating scales for frequency of performance and seriousness of inadequate or incorrect performance. These two rating scales were used because they provide useful information (i.e., how critical each task is and how frequently each task is performed) pertaining to certification. The task inventory was sent to 220 certified very small water system operators throughout the United States and Canada. Ninety-three out of the 220 inventories mailed were returned for a response rate 42%.

Analysis of Ratings

The mean, standard deviation, and the percentage of respondents performing each task statement were computed. The mean was used to determine the importance of items and the standard deviation was used to identify items with a wide variation in responses. The percentage of respondents performing each task statement was used to identify tasks and capabilities commonly performed by operators throughout the United States and Canada.

A criticality value of 2(mean seriousness rating) + mean frequency rating was calculated for each item on the inventory. This formula gives extra weight to the seriousness rating in determining critical items and was appropriate because it emphasized the purpose of certification—to provide competent operators.

Core Competencies

The criticality ratings and percentage of operators reporting that they performed the tasks were used to determine what is covered on the very small water system exam. The essential tasks and capabilities that were identified through this process are called the core competencies. The following pages list the core competencies for very small water system operators. The core competencies are clustered into the following job duties:

- Operate System
- Water Quality Parameters and Sampling
- Operate Equipment
- Install, Maintain and Evaluate Equipment
- Perform Safety Duties
- Perform Administrative and Compliance Duties

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Core Competencies for Very Small Water System Operators

Operate System

System Design
- Assess system demand
- Flushing program
- System layout
- System map
- Perform pressure readings
- Read blueprints, readings, and maps
- Select materials
- Select type of pipes
- Size mains

System Inspection
- Cross connection surveys/control
- Sample site plan
- Sanitary surveys
- Well inspection

Chlorine Disinfection
- Monitor disinfection process
- Evaluate disinfection process
- Adjust disinfection process

Required capabilities:
- Ability to adjust flow patterns and system units
- Ability to communicate verbally and in writing
- Ability to diagnose/troubleshoot system units
- Ability to discriminate between normal and abnormal conditions
- Ability to evaluate system units
- Ability to inspect pumps
- Ability to maintain system in normal operating condition
- Ability to monitor and adjust equipment
- Ability to perform basic math
- Knowledge of blueprint readings
- Knowledge of cathodic protection
- Knowledge of different types of joints, restraints and thrust blocks
- Knowledge of disinfection concepts and design parameters
- Knowledge of disinfection process
- Knowledge of fireflow requirements
- Knowledge of general chemistry, biology and physical science
- Knowledge of general electrical and hydraulic principles
- Knowledge of hydrology
- Knowledge of measuring instruments
- Knowledge of monitoring requirements
- Knowledge of piping material, type and size
- Knowledge of principles of measurement
- Knowledge of regulations
- Knowledge of sampling procedures and requirements
- Knowledge of sanitary survey process
- Knowledge of standards
- Knowledge of start-up and shut-down procedures
- Knowledge of testing instruments
- Knowledge of well drilling principles
- Knowledge of well-head protection

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Water Quality Parameters and Sampling

- Chlorine demand/residual/dosage
- Coliforms
- pH
- Temperature
- Turbidity

Required capabilities:

- Ability to calibrate instruments
- Ability to follow written procedures
- Ability to interpret Material Safety Data Sheets
- Ability to perform basic math
- Ability to recognize normal and abnormal analytical results
- Knowledge of basic laboratory equipment
- Knowledge of chemical handling and storage
- Knowledge of general biology, chemistry and physical science
- Knowledge of normal characteristics of water
- Knowledge of principles of measurement
- Knowledge of public notification requirements
- Knowledge of quality control/quality assurance practices
- Knowledge of regulations
- Knowledge of reporting requirements
- Knowledge of safety procedures
- Knowledge of sampling procedures

Operate Equipment

- Blowers and compressors
- Centrifugal pumps
- Chemical feeders
- Chlorinators
- Hydrants
- Hydraulic equipment
- Instrumentation
- Leak detectors
- Positive-displacement pumps
- Valves

Required capabilities:

- Ability to monitor, evaluate and adjust equipment
- Knowledge of drinking water concepts
- Knowledge of function of tools
- Knowledge of general electrical and mechanical principles
- Knowledge of hydraulic and pneumatic principles
- Knowledge of regulations
- Knowledge of safety procedures
- Knowledge of start-up and shut-down procedures
- Knowledge of system operation and maintenance

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Core Competencies (continued)

Install, Maintain and Evaluate Equipment

Install and maintain equipment:

- Backflow prevention devices
- Chemical feeders
- Chlorinators
- Corrosion control
- Electric motors
- Hydrants
- Meters
- Pipe repair
- Pumps
- Service connection
- Storage tanks
- Taps
- Valves
- Water mains

Evaluate operation of equipment:

- Inspect equipment for abnormal conditions
- Read charts
- Read meters
- Read pressure gauges
- Troubleshoot electrical equipment

Required capabilities:

- Ability to calibrate equipment
- Ability to diagnose/troubleshoot equipment
- Ability to differentiate between preventive and corrective maintenance
- Ability to discriminate between normal and abnormal conditions
- Ability to evaluate and adjust equipment
- Ability to follow written procedures
- Ability to order necessary spare parts
- Ability to perform general maintenance
- Ability to record information
- Knowledge of corrosion control processes
- Knowledge of dechlorination and disinfection processes
- Knowledge of different types of cross-connections and approved backflow methods and devices
- Knowledge of general electrical, mechanical, hydraulic and pneumatic principles
- Knowledge of lubricant and fluid characteristics
- Knowledge of pipe fittings and joining methods
- Knowledge of piping material, type and size
- Knowledge of regulations
- Knowledge of start-up and shut-down procedures
- Knowledge of system operation and maintenance

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Core Competencies (continued)

Perform Safety Procedures

- Chemical handling
- Confined space entry
- Electrical hazards
- Fire safety
- Lock-out/tag-out
- Personal protective equipment
- Traffic/work zone

Required capabilities:

- Ability to communicate verbally and in writing
- Ability to interpret Material Safety Data Sheets
- Ability to recognize unsafe work conditions/safety hazards
- Ability to select and operate safety equipment
- Knowledge of emergency plans
- Knowledge of potential causes and impact of system disasters
- Knowledge of risk management
- Knowledge of safety procedures

Perform Administrative and Compliance Duties

Administrative and Security

- Administer compliance, emergency preparedness and safety program
- Develop budget
- Develop operation and maintenance plan
- Plan and organize work activities
- Record and evaluate data
- Respond to complaints
- Write regulatory authority reports

Comply with Drinking Water Regulations

United States Exams –

- Code of Federal Regulations, Title 40, Part 141 - National Primary Drinking Water Regulations:
  - Subpart A - General definitions
  - Subpart B - Maximum contaminant levels
  - Subpart C - Monitoring and analytical requirements
  - Subpart D - Reporting and recordkeeping
  - Subpart I - Control of lead and copper
  - Subpart Q - Public notification of drinking water violations

Canadian Exams

- Provincial and territorial regulations

Required capabilities:

- Ability to assess likelihood of disaster occurring
- Ability to communicate verbally and in writing
- Ability to coordinate emergency response with other organizations
- Ability to generate written policies and procedures
- Ability to interpret and transcribe data
- Ability to organize information and review reports
- Ability to perform basic math
- Ability to perform impact assessments
- Ability to translate technical language into common terminology
- Knowledge of emergency plans
- Knowledge of local codes and ordinances
- Knowledge of monitoring and reporting requirements
- Knowledge of potential causes and impact of system disasters
- Knowledge of principles of finance
- Knowledge of principles of management
- Knowledge of principles of public relations
- Knowledge of public notification requirements
- Knowledge of public participation process
- Knowledge of recordkeeping function and policies
- Knowledge of regulations
- Knowledge of risk management
- Knowledge of system operation and maintenance

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Very Small Water System Certification Exam

The very small water system certification exam evaluates an operator's knowledge of tasks related to the operation of small water systems. The content of the exam was determined from the results of the job analysis. To successfully take an ABC exam, an operator must demonstrate knowledge of the core competencies in this document.

The very small water system exam consists of 50 multiple-choice questions. The specifications for the exams are based on a weighting of the job analysis results so that they reflect the criticality of tasks performed on the job. The specifications list the percentage of questions on the exam that fall under each job duty. For a list of tasks and capabilities associated with each job duty, please refer to the list of core competencies on the previous pages.

ABC Very Small Water System Exam Specifications

Job Duty	**Percent of Exam**
Operate System	22%
Water Quality Parameters and Sampling	20%
Operate Equipment	10%
Install, Maintain and Evaluate Equipment	16%
Perform Safety Duties	14%
Perform Administrative and Compliance Duties	18%

Suggested References

The following are approved as reference sources for the ABC very small water system examination. Operators should use the latest edition of these reference sources to prepare for the exam.

American Water Works Association (AWWA)

- *Water Transmission and Distribution*
- *Water Quality*
- *Basic Science Concepts and Applications*
- *Water Distribution Operator Training Handbook*
- *Water System Security, A Field Guide*

To order, contact: American Water Works Association
6666 West Quincy Ave.
Denver, CO 80235

Web site: www.awwa.org
Phone: (800) 926-7337
Fax: (303) 347-0804
E-mail: custsvc@awwa.org

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California State University, Sacramento (CSUS) Foundation, Office of Water Programs

- *Water Distribution System Operation and Maintenance*
- *Small Water System Operation and Maintenance*
- *Utility Management*
- *Manage for Success*

To order, contact: Office of Water Programs
California State University, Sacramento
6000 J Street
Sacramento, CA 95819-6025

Web site: www.owp.csus.edu
Phone: (916) 278-6142
Fax: (916) 278-5959
E-mail: wateroffice@owp.csus.edu

Regulations

For United States exams:

- *Code of Federal Regulations*, Title 40, Part 141 (www.gpo.gov)
- State regulations (contact information for state certification programs is available on the Certification Contacts page of ABC's web site, www.abccert.org)

For Canadian exams:

- *Guidelines for Canadian Drinking Water Quality*. Federal-Provincial-Territorial Subcommittee on Drinking Water. Ottawa, ON: Health Canada (www.hc-sc.gc.ca/waterquality)
- Provincial and territorial regulations (contact information for provincial/territorial certification programs is available on the Certification Contacts page of ABC's web site, www.abccert.org)

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ABC & C_2EP Formula/Conversion Table for Water Treatment, Distribution, & Laboratory Exams

Alkalinity, as mg $CaCO_3$/L $= \dfrac{\text{(Titrant Volume, mL) (Acid Normality) (50,000)}}{\text{Sample Volume, mL}}$

Amps $= \dfrac{\text{Volts}}{\text{Ohms}}$

*Area of Circle = (.785) (Diameter^2)

= (π) (Radius^2)

Area of Cone (lateral area) = (π) (Radius) $\sqrt{\text{Radius}^2 + \text{Height}^2}$

Area of Cone (total surface area) = (π) (Radius) (Radius + $\sqrt{\text{Radius}^2 + \text{Height}^2}$)

Area of Cylinder (total exterior surface area) = [Surface Area of End #1] + [Surface Area of End #2] + [(π) (Diameter) (Height or Depth)]

*Area of Rectangle = (Length) (Width)

*Area of a Right Triangle $= \dfrac{\text{(Base) (Height)}}{2}$

Average (arithmetic mean) $= \dfrac{\text{Sum of All Terms}}{\text{Number of Terms}}$

Average (geometric mean) = $[(X_1)\,(X_2)\,(X_3)\,(X_4)\,(X_n)]^{1/n}$ *The* n*th root of the product of* n *numbers*

Chemical Dry Feeder Calibration, lbs/day $= \dfrac{\text{(Dry Chemical Collected, grams) (60 min/hr) (24 hr/day)}}{\text{(454 grams/lb) (Time, min)}}$

Chemical Feed Pump Setting, % Stroke $= \dfrac{\text{Desired Flow}}{\text{Maximum Flow}} \times 100\%$

Chemical Feed Pump Setting, mL/min $= \dfrac{\text{(Flow, MGD) (Dose, mg/L) (3.785 L/gal) (1,000,000 gal/MG)}}{\text{(Liquid, mg/mL) (24 hr/day) (60 min/hr)}}$

Circumference of Circle = (π) (Diameter)

= 2 (π) (Radius)

Composite Sample Single Portion $= \dfrac{\text{(Instantaneous Flow) (Total Sample Volume)}}{\text{(Number of Portions) (Average Flow)}}$

CT Calculation = (Disinfectant Residual Concentration, mg/L) (Time, min)

Degrees Celsius = (Degrees Fahrenheit - 32) ($^5/_9$)

$= \dfrac{(°F - 32)}{1.8}$

*Pie Wheel format for this equation is available at the end of this document.

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Degrees Fahrenheit $= (\text{Degrees Celsius})\left(\frac{9}{5}\right) + 32$

$= (\text{Degrees Celsius})(1.8) + 32$

Detention Time $= \frac{\text{Volume}}{\text{Flow}}$ *Units must be compatible*

*Electromotive Force (EMF), volts = (Current, amps) (Resistance, ohms) *or* E = IR

*Feed Rate, lbs/day $= \frac{(\text{Dosage, mg/L})(\text{Capacity, MGD})(8.34\text{ lbs/gal})}{\text{Purity, \% expressed as a decimal}}$

Feed Rate, gal/min (Fluoride Saturator) $= \frac{(\text{Plant capacity, gpm})(\text{Dosage, mg/L})}{18{,}000\text{ mg/L}}$

Feed Rate, lbs/day (Fluoride) =

$$\frac{(\text{Dosage, mg/L})(\text{Capacity, MGD})(8.34\text{ lbs/gal})}{(\text{Available Fluoride Ion, \% expressed as a decimal})(\text{Purity, \% expressed as a decimal})}$$

Filter Backwash Rise Rate, in/min $= \frac{(\text{Backwash Rate, gpm/ft}^2)(12\text{ in/ft})}{7.48\text{ gal/ft}^3}$

Filter Drop Test Velocity, ft/min $= \frac{\text{Water Drop, ft}}{\text{Time of Drop, min}}$

Filter Flow Rate or Backwash Rate, gpm/ft^2 $= \frac{\text{Flow, gpm}}{\text{Filter Area, ft}^2}$

Filter Yield, lbs/hr/ft^2 $= \frac{(\text{Solids Loading, lbs/day})(\text{Recovery, \% expressed as a decimal})}{(\text{Filter Operation, hr/day})(\text{Area, ft}^2)}$

*Flow Rate, cfs = (Area, ft^2) (Velocity, ft/sec) *or* Q = AV *Units must be compatible*

*Force, lbs = (Pressure, psi) (Area, in^2)

Gallons/Capita/Day $= \frac{\text{Volume of Water Produced, gpd}}{\text{Population}}$

Hardness, as mg $CaCO_3$/L $= \frac{(\text{Titrant Volume, mL})(1{,}000)}{\text{Sample Volume, mL}}$ *Only when the titration factor is 1.00 of EDTA*

Horsepower, Brake (bhp) $= \frac{(\text{Flow, gpm})(\text{Head, ft})}{(3{,}960)(\text{Pump Efficiency, \% expressed as a decimal})}$

Horsepower, Motor (mhp) =

$$\frac{(\text{Flow, gpm})(\text{Head, ft})}{(3{,}960)(\text{Pump Efficiency, \% expressed as a decimal})(\text{Motor Efficiency, \% expressed as a decimal})}$$

*Horsepower, Water (whp) $= \frac{(\text{Flow, gpm})(\text{Head, ft})}{3{,}960}$

Hydraulic Loading Rate, gpd/ft^2 $= \frac{\text{Total Flow Applied, gpd}}{\text{Area, ft}^2}$

*Pie Wheel format for this equation is available at the end of this document.

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$$\text{Hypochlorite Strength, \%} = \frac{\text{Chlorine Required, lbs}}{(\text{Hypochlorite Solution Needed, gal})(8.34\text{ lbs/gal})} \times 100\%$$

$$\text{Leakage, gpd} = \frac{\text{Volume, gallons}}{\text{Time, days}}$$

*Mass, lbs = (Volume, MG) (Concentration, mg/L)(8.34 lbs/gal)

*Mass Flux, lbs/day = (Flow, MGD) (Concentration, mg/L) (8.34 lbs/gal)

Milliequivalent = (mL) (Normality)

$$\text{Molarity} = \frac{\text{Moles of Solute}}{\text{Liters of Solution}}$$

$$\text{Normality} = \frac{\text{Number of Equivalent Weights of Solute}}{\text{Liters of Solution}}$$

$$\text{Number of Equivalent Weights} = \frac{\text{Total Weight}}{\text{Equivalent Weight}}$$

$$\text{Number of Moles} = \frac{\text{Total Weight}}{\text{Molecular Weight}}$$

$$\text{Reduction in Flow, \%} = \left(\frac{\text{Original Flow - Reduced Flow}}{\text{Original Flow}}\right) \times 100\%$$

$$\text{Removal, \%} = \left(\frac{\text{In} - \text{Out}}{\text{In}}\right) \times 100\%$$

$$\text{Slope, \%} = \frac{\text{Drop or Rise}}{\text{Distance}} \times 100\%$$

$$\text{Solids, mg/L} = \frac{(\text{Dry Solids, grams})(1{,}000{,}000)}{\text{Sample Volume, mL}}$$

$$\text{Solids Concentration, mg/L} = \frac{\text{Weight, mg}}{\text{Volume, L}}$$

$$\text{Specific Gravity} = \frac{\text{Specific Weight of Substance, lbs/gal}}{\text{Specific Weight of Water, lbs/gal}}$$

$$\text{Surface Loading Rate or Surface Overflow Rate, gpd/ft}^2 = \frac{\text{Flow, gpd}}{\text{Area, ft}^2}$$

Three Normal Equation = $(N_1 \times V_1) + (N_2 \times V_2) = (N_3 \times V_3)$ *Where* $V_1 + V_2 = V_3$

Two Normal Equation = $N_1 \times V_1 = N_2 \times V_2$ *Where N = normality, V = volume or flow*

$$\text{Velocity, ft/sec} = \frac{\text{Flow Rate, ft}^3\text{/sec}}{\text{Area, ft}^2}$$

$$= \frac{\text{Distance, ft}}{\text{Time, sec}}$$

*Volume of Cone = (1/3) (.785) (Diameter^2) (Height)

= (1/3) [(π) (Radius^2) (Height)]

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*Volume of Cylinder = (.785) (Diameter^2) (Height)

= (π) (Radius^2) (Height)

*Volume of Rectangular Tank = (Length) (Width) (Height)

Watts (AC circuit) = (Volts) (Amps) (Power Factor)

Watts (DC circuit) = (Volts) (Amps)

$$\text{Weir Overflow Rate, gpd/ft} = \frac{\text{Flow, gpd}}{\text{Weir Length, ft}}$$

$$\text{Wire-to-Water Efficiency, \%} = \frac{\text{Water Horsepower, hp}}{\text{Power Input, hp or Motor hp}} \times 100\%$$

$$\text{Wire-to-Water Efficiency, \%} = \frac{\text{(Flow, gpm) (Total Dynamic Head, ft) (0.746 kW/hp)}}{\text{(3,960) (Electrical Demand, kilowatts)}} \times 100\%$$

Abbreviations:

cfs	cubic feet per second
DO	dissolved oxygen
ft	feet
g	grams
gpd	gallons per day
gpg	grains per gallon
gpm	gallons per minute
hp	horsepower
hr	hour
in	inches
kW	kilowatt
lbs	pounds
mg/L	milligrams per liter
MGD	million gallons per day
mL	milliliter
min	minute
ppb	parts per billion
ppm	parts per million
psi	pounds per square inch
Q	flow
SS	settleable solids
TTHM	total trihalomethanes
TOC	total organic carbon
TSS	total suspended solids
VS	volatile solids

Conversion Factors:

1 acre = 43,560 square feet
1 acre foot = 326,000 gallons
1 cubic foot = 7.48 gallons
= 62.4 pounds
1 cubic foot per second = 0.646 MGD
1 foot = 0.305 meters
1 foot of water = 0.433 psi
1 gallon = 3.79 liters
= 8.34 pounds
1 grain per gallon = 17.1 mg/L
1 horsepower = 0.746 kW
= 746 watts
= 33,000 ft lbs/min
1 mile = 5,280 feet
1 million gallons per day = 694 gallons per minute
= 1.55 cubic feet per second (cfs)
1 pound = 0.454 kilograms
1 pound per square inch = 2.31 feet of water
1 ton = 2,000 pounds
1% = 10,000 mg/L
π or pi = 3.14159

Alkalinity Relationships: All Alkalinity expressed as mg/L as $CaCO_3$

Result of Titration	Hydroxide Alkalinity	Carbonate Alkalinity	Bicarbonate Concentration
P = 0	0	0	T
P < ½T	0	2P	T – 2P
P = ½T	0	2P	0
P > ½T	2P – T	2(T – P)	0
P = T	T	0	0

Key: P – phenolphthalein alkalinity T – total alkalinity

*Pie Wheel format for this equation is available at the end of this document.

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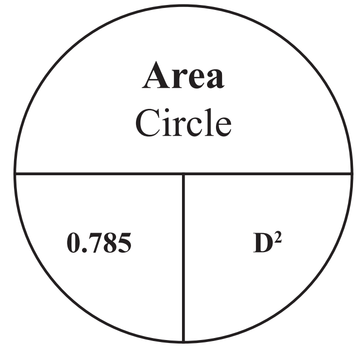
***Pie Wheels:**

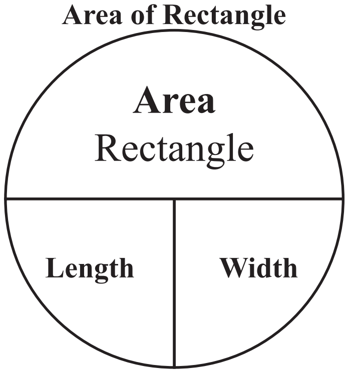
- To find the quantity above the horizontal line: multiply the pie wedges below the line together.
- To solve for one of the pie wedges below the horizontal line: cover that pie wedge, then divide the remaining pie wedge(s) into the quantity above the horizontal line.

Given units must match the units shown in the pie wheel.

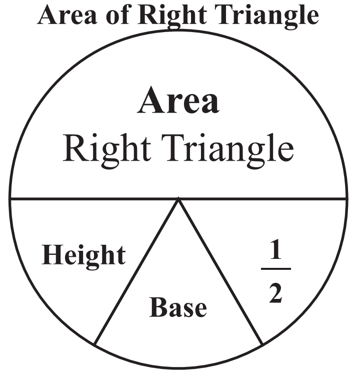
Area of Circle



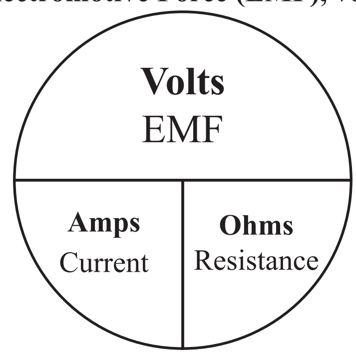
Area of Rectangle



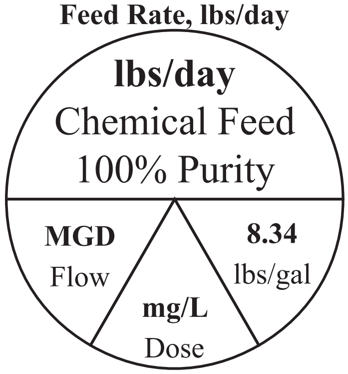
Area of Right Triangle



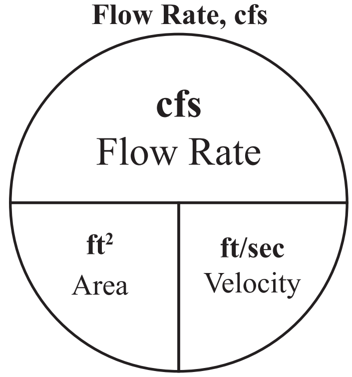
Electromotive Force (EMF), volts



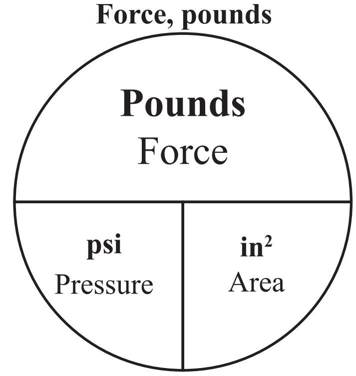
Feed Rate, lbs/day



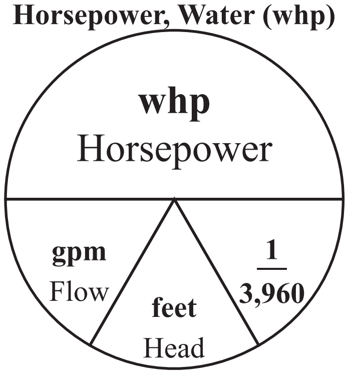
Flow Rate, cfs



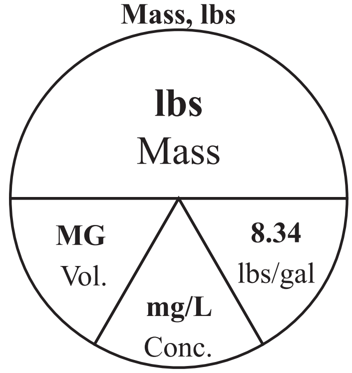
Force, pounds



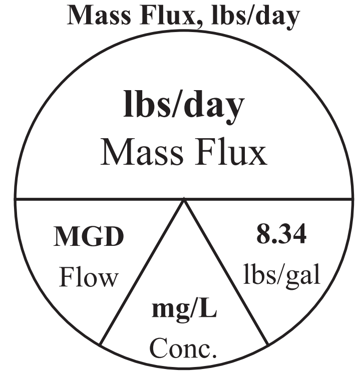
Horsepower, Water (whp)



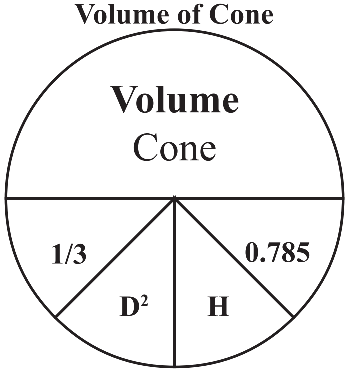
Mass, lbs



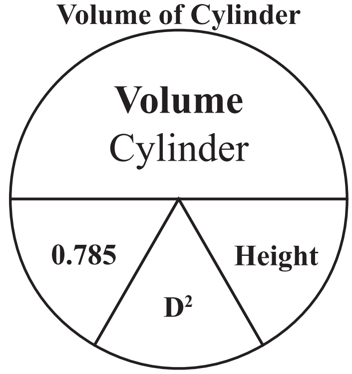
Mass Flux, lbs/day



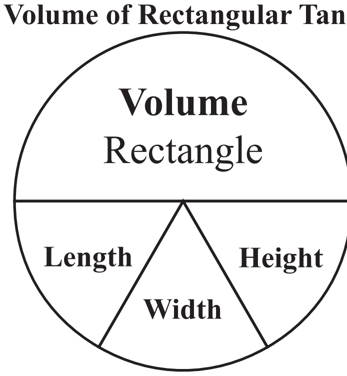
Volume of Cone



Volume of Cylinder



Volume of Rectangular Tank



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ARKANSAS WATER DISTRIBUTION LICENSE -- MATHEMATICS STUDY GUIDE

The key to studying for the math portion of the license exam begins with the formula sheet. The formula sheet should serve as a guide to the type of questions that will be encountered on the exams. By using the formula sheet and the California text practice questions, a better understanding of the required math should be made more apparent.

The following is a list of math categories that relate to the formula sheet. Examples of some problems have been noted for study. The examples shown **do not** depict the only application that each formula may be used. These examples can be utilized to see how some formulas are executed. All formulas and examples may not be included. You may also find other examples of problems on your own.

In the "EXAMPLE" Column of the table below, **"A"** denotes sample problems located in the Arithmetic Appendix and **"Ch"** denotes chapter of the treatment books. The numbers are the chapter and/or section of that part of the treatment books.

FORMULA TOPIC	CSUS BOOK	EXAMPLE
Area of Circle	Distribution O&M	A.23 Circle
Area of Cylinder	Distribution O&M	A.24 Cylinder
Area of Rectangle	Distribution O&M	A.21 Rectangle
Area of Triangle	Distribution O&M	A.22 Triangle
Average (arithmetic mean)	Distribution O&M	Ch 5.21
Average (Quarterly), ug/L	Distribution O&M	Ch 5.21 example # 1
Average (Running Quarterly Annual), ug/L	Distribution O&M	Ch 5.21 example # 3
Chemical Feed Pump Setting, % Stroke	Treatment I	A.131 example # 5
Chemical Feed Pump Setting, mL/min	Small System O&M	A.153
Circumference of Circle	Distribution O&M	A.23 Circle
Degrees Celsius	Distribution O&M	A.43
Degrees Fahrenheit	Distribution O&M	A.43
Detention Time	Distribution O&M	A.30 example # 3
Discharge Rate	Distribution O&M	A.86 example c
Efficiency	Distribution O&M	A.86
Electromotive Force (E.M.F), volts	Treatment II	Ch 18.114
Feed Rate, (Dosage), lbs	Distribution O&M	A.131
Feed Rate (Dosage), lbs/day	Distribution O&M	A.131 example # 2
Flow Rate, cfs	Distribution O&M	A.71
Force, pounds	Distribution O&M	A.6
Gallons/Capita/Day	Small System O&M	Ch 8.02
Horsepower, Brake (bhp)	Distribution O&M	A.83
Horsepower Brake	Distribution O&M	A.86
Horsepower, Motor (mhp)	Distribution O&M	A.84
Horsepower, Water (whp)	Distribution O&M	A.86
Hypochlorite Strength, %	Distribution O&M	A.134.3
Motor Efficiency, %	Distribution O&M	A.86
Motor Power Input	Distribution O&M	A.83
Pump Capacity, gpm	Distribution O&M	A.86 1 Capacity
Pump Efficiency %	Distribution O&M	A.86 2 Efficiency
Velocity, ft/sec	Small System O&M	A.7
Volume of Cone	Distribution O&M	A.33 Cone
Volume of Cylinder	Distribution O&M	A.32 Cylinder
Volume of Rectangular Unit	Distribution O&M	A.30 Rectangle
Watts (DC circuit)	Treatment II	Ch 18.115
Wire to Water Efficiency, %	Distribution O&M	A.86